Please amend the present application as follows:

In the Specification

The following is a copy of Applicant's specification that identifies language being added with underlining ("___") and language being deleted with double square brackets ("[[ ]]") or strikethrough ("—"), as is applicable:

Page 3, paragraphs [0014] through [0020].

FIG. 1 is a schematic diagram that illustrates one ~~exemplar~~ exemplary implementation for the embodiments of the invention.

FIGS. 2A-2C are schematic diagrams that illustrate several piezoelectric beam resonator embodiments.

FIG. 3 is a schematic diagram that illustrates a piezoelectric block resonator embodiment.

FIG. 4A is a flow diagram that illustrates one method embodiment for fabricating the piezoelectric resonator embodiments shown in FIGS. 2A-3.

FIGS. 4B-4E are schematic diagrams that illustrate the method shown in FIG. 4A.

FIG. 5 is a schematic diagram that illustrates an equivalent electrical circuit for the piezoelectric resonator embodiments of FIGS. 2A-3.

FIG. 6 is a graph that illustrates resonance frequency as a function of direct current (DC) voltage for the piezoelectric resonator embodiments of FIGS. 2A-3.

Page 5, paragraphs [0025] through [0026].

FIG. 1 is a schematic diagram that illustrates one ~~exemplar~~ exemplary implementation for the embodiments of the invention. Select receiver components of a communication device 120 are shown, with the understanding that transmitter components can also benefit from the embodiments of the invention. The communication device 120 can include a portable transceiver, such as a cellular phone, among other devices. The communication

device 120 includes an antenna 102, piezoelectric resonator devices 100a-100c configured as frequency selective filters, low-noise amplifiers 106 and 114, mixers 108 and 116, voltage-controlled oscillators 110 and 118, and a frequency reference piezoelectric resonator device 100d. All components shown except for resonator devices 100a-100d are known, and thus further explanation is omitted for brevity. The use of piezoelectric resonators 100a-100d can result in a reduction in the number of components in the communication device 120. Piezoelectric resonators 100a-100d are very selective at high frequencies, thus substantially obviating the need for pre-amplifier selection and other frequency transformation and/or amplification devices that operate to provide signal processing at frequencies that current devices most efficiently operate under. The piezoelectric resonator devices of the preferred embodiments possess high quality factors at high frequencies, enabling frequency selection with substantially fewer components.

FIGS. 2A-2C are schematic diagrams that illustrate several piezoelectric beam resonator embodiments. FIG. 2A is a schematic diagram of a first embodiment configured as a clamped-clamped resonator beam 200a. The clamped-clamped resonator beam 200a includes a handle layer 202, an oxide layer 204, a device layer 206, a piezoelectric layer 208, a drive electrode 210, and a sense electrode 212a. The "clamped" regions 201 and 203 correspond to the location where the ~~piezoelectric resonator 200a~~ <u>SOI substrate</u> is secured to the underlying handle layer 202, which in turn can be secured to a printed circuit board, among other devices. In some embodiments, the underlying handle layer 202 is the substrate in an integrated circuit, to which the SOI portion is secured. The "beam" region 205, having a length "L," spans between the two clamped regions 201 and 203, and includes the portion of the piezoelectric resonator 200a that is free to vibrate. The device layer 206 and the oxide layer 204 collectively represent the SOI substrate. Some exemplary thicknesses of the device layer 206 (*e.g.*, Ts) can range from approximately 4.0 – 5.0 microns, although different thickness ranges are possible (*e.g.*, 0.2 microns - 30 microns). Some exemplary thicknesses of the oxide layer 204 range from approximately 1.0 – ~~1.5~~ <u>5</u> microns. The handle layer 202 provides mechanical support for the clamped-clamped beam resonator 200a. The piezoelectric layer 208 is disposed in precise locations between the electrodes 210 and 212a and the device layer 206. The piezoelectric layer 208 can have a thickness of 0.2 microns – 0.3

microns, as one example range. The device layer 206 can be a low resistivity SCS substrate, with higher quality silicon (*e.g.*, zero or substantially zero defects) situated in the upper region of the device layer 206. The electrodes 210 and 212a can be comprised of aluminum, among other metals, and example thicknesses include a range of 0.1 – 0.2 microns. The absence of a bottom metal electrode (*e.g.*, a bottom electrode is conventionally used for piezoelectric devices) reduces the number of stacked layers, which could ultimately affect the mechanical Q of the resonator.

Page 7, paragraph [0028].

Well-known admittance models of a doubly-clamped piezoelectric beam resonator can be used with modification to model the behavior of the clamped-clamped resonator beam 200a. The electromechanical coupling coefficients at the drive electrode 210, η_{in}, and at the sense electrode 212a, η_{out} of the clamped-clamped resonator beam 200a are expressed by:

$$\eta_{in} = \frac{d_{31}E_pT_s}{2}\int_0^L W_i''(x)\Phi(x)dx \qquad \text{(Eq. 1)}$$

$$\eta_{out} = -\frac{d_{31}E_pT_s}{2}\int_0^L W_0(x)\Phi''(x)dx \qquad \text{(Eq. 2)}$$

where d_{31} is the transverse piezoelectric coefficient, E_p is the modulus of elasticity of ZnO, and $\Phi(x)$ is the function describing the mode shape of the clamped-clamped resonator beam 200a. Note that slightly different equations for piezoelectric resonator blocks apply, as would be understood by those having ordinary skill in the art. Ts is the height~~ from the top surface of the handle layer to the bottom surface of the piezoelectric layer~~ of the device layer 206. The equivalent motional resistance of the resonating element (*e.g.*, the beam 205) depends on the squared inverse of the electromechanical coupling. Therefore the values of η_{in} and η_{out} are preferably maximized to achieve low values of the motional resistance. The maximum value of the two integrals in Eqs. 1 and 2 occurs for electrode edges placed at inflection points of the

beam mode shape. In one embodiment, the inflection points coincide with 22.4% and 77.6% of the beam length. Therefore the final input to output admittance, Y_{oi}, of an SCS resonator (*i.e.*, a resonator that includes a device layer comprised of SCS) with piezoelectric transduction becomes:

$$Y_{oi} = \frac{\left(2.49 \cdot d_{31} E_p T_s \frac{W}{L}\right)^2 s}{M_1 s^2 + \frac{M_1 \omega_n}{Q} s + K_1} \qquad \text{(Eq. 3)}$$

where M_1 and K_1 are first mode equivalent mass and stiffness of the micromechanical resonator, ω_n is the natural resonance frequency of the beam, s is the Laplace variable, and W is the width of the electrodes 210 and 212a. If the thickness of the piezoelectric layer 208 is negligible compared to the height, Ts, of the silicon material of the resonator body, the resonance frequency can be approximately expressed by the equation for a beam with isotropic properties:

$$f_0 = 1.03 \frac{T_s}{L^2} \sqrt{\frac{E_s}{\rho_s}} \qquad \text{(Eq. 4)}$$

where E_s and ρ_s [[s]] are respectively the modulus of elasticity and the density of silicon.

Page 10, paragraph [0033].

FIG. 4A is a flow diagram that illustrates one method for fabricating the piezoelectric resonator embodiments shown in FIGS. 2A-3. Note that the method is based on one implementation, and that alternate implementations are included within the scope of the preferred embodiments of the invention such that steps can be omitted, added to, and/or executed out of order from that shown or discussed, as would be understood by those reasonably skilled in the art of the present invention. FIGS. 4B-4E are schematic diagrams that are used in cooperation with FIG. 4A to illustrate some of the structural changes that occur during the fabrication method. In general, the fabrication

method of the preferred embodiments includes a simple three-mask process that can be used as a fabrication technology for SCS (or other) microelectromechanical resonators used for piezoelectric transduction. Structures similar to or the same as those shown for the clamped-clamped resonator beam 200b of FIG. 2B are used as a non-limiting example, with the understanding that the process applies similarly to the other embodiments shown in FIGS. 2B, 2C and 3. As shown in FIG. 4B, structure 400a comprises a handle layer 202 adjacent to a semiconductor-on-insulator (SOI) substrate. The SOI substrate comprises an oxide layer 204 and a device layer 206. The oxide layer 204, as described above, is disposed between the handle layer 202 and the device layer 206.

Page 15, paragraph [0048].

FIG. 5 shows a circuit arrangement 500 including an equivalent circuit ~~500~~502 for modeling the resonance behavior of a piezoelectric beam and block resonators of the preferred embodiments and a trans-resistance amplifier circuit 504 that can be used in conjunction with the equivalent circuit 502. As shown, the equivalent circuit 502 includes an input voltage (V_{in}) which corresponds to the potential at a drive electrode. Vin can be, for example, 1 millivolts (mV) to 100 mV. The equivalent circuit 502 includes parasitic capacitance (C_p) associated with the capacitance between the bonding pads and ground. The feed-through capacitance, C_{FT} corresponds to the capacitance between the input and output port (*e.g.*, the distance between the electrodes located on the beam 205 of FIG. 2A). The body of the resonator (*e.g.*, resonating element) can be modeled with the series capacitor (C_m), resistor (R_m), and inductor (L_m). For example, the frequency response of the mechanical resonator is determined by:

$$f = 1/[(2\pi(LC)^{1/2}] \qquad \text{(Eq. 6)}$$